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Robust Watermarking Method for Color Images Using DCT Coefficients of Watermark

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ROBUST WATERMARKING METHOD FOR COLOR IMAGES USING DCT COEFFICIENTS OF WATERMARK

Strictly as per the compliance and regulations of:

Robust Watermarking Method for Color Images Using DCT Coefficients of Watermark

R.Eswaraiah [α] & E.Sreenivasa Reddy [σ]

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I. Introduction

Now days the rapid growth of the technology is a cause for the requirement of the protection of copyright information from unauthorized access. Hence an advanced authentication method is essential to the data security. Digital watermarking is one such method that offers data security. At present various kinds of digital watermarking methods are in use to protect the information from unauthorized access. Any security method come under either spatial [1] like LSB or frequency domain [2] like Discrete Wavelet Transform (DWT) [5], Discrete Cosine Transform (DCT) [3], Discrete Fourier Transform (DFT) [6] and the combination of them [7, 8] as well as any method can come under either blind or non blind watermarking. In blind watermarking the cover image is not used to decipher the watermark [3]. The cover image is used to decipher the watermark in the non-blind watermarking [4]. This paper proposes a non blind watermarking method based on the frequency domain. This method uses the transformations to improve the robustness of the system. The necessary features are perceptual quality and robustness to determine the quality of watermarking scheme.

In the frequency domain, DWT decomposes an image into multi-resolution components i.e. horizontal, vertical and diagonal [5] and DCT segregate each block into three frequency sub-bands: low, mid and high [3]. DFT requires an input image that is discrete. Such inputs are often created by sampling a continuous function. But, in this correspondence, DWT- DCT combination [7] and DCT coefficients of watermark are used in the proposed method. It improves all security factors in the data transfer. The strength of this paper is, analysis of the proposed scheme based on the standard metrics such as PSNR and NC and it sustains the general attacks like Gaussian noise, salt & pepper noise, Poisson noise, Gaussian blur, sharpening and common image processing operations like cropping, JPEG compression. The rest of the paper is organized in the following way. Section 2 consists of proposed method. Section 3 holds the description of performance metrics. Results and analysis are illustrated in Section 4.

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II. Proposed Method

The main aim of the proposed method is to improve the quality of watermarked image and robustness of the watermark. This approach consists of two major processes.

- Applying DWT and DCT on RGB cover image to get transformed image.
- Embed DCT coefficients of watermark image into transformed image.

a) Watermark Embedding Algorithm

In watermark embedding process, till now researchers are using either DWT or DCT or both transformations. Here, we are using both DWT and DCT to transform the cover image as transformed image and a new and efficient embedding algorithm which embeds DCT coefficients of watermark image into transformed image to get the watermarked image as shown in Fig 1. It is elucidated in the following way.

Algorithm

Step 1: Consider any color image as cover image denote it by 'I'. Get R, G, B channels of cover image 'I'.

Step 2: Apply DWT to blue channel 'B' to get the multi-resolution sub-bands LL1, HL1, LH1, and HH1. When compared to red and green channels blue channel is more resistant to changes.

Step 3: Apply DWT again to HL1 sub-band of B channel and choose HL2 sub-band.

Step 4: Divide the HL2 sub-band into blocks of size 8×8.

Step 5: Apply DCT to the blocks obtained in step 4.

Step 6: Consider any gray scale image as watermark, denote it by 'w' and then apply DCT to the watermark 'w'.

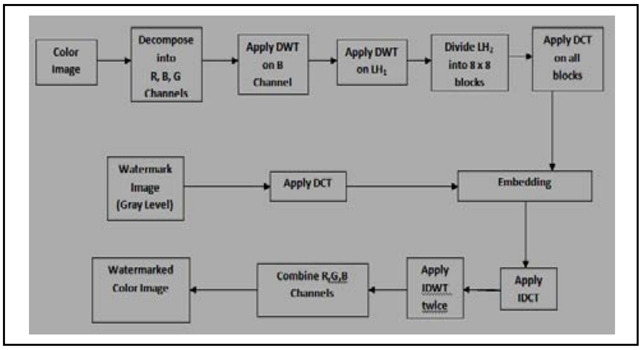

Figure 1 : Watermark embedding process

Step 7: To embed the watermark, select any four coefficients in the mid frequency band of each DCT block of HL2 sub-band.

Step 8: Four DCT coefficients of watermark are stored in each DCT block of HL2 sub-band.

Step 9: The DC component from the DCT coefficients of watermark is normalized before embedding.

Step 10: Apply IDCT to the blocks of HL2 sub-band.

Step 11: Apply IDWT for 2 levels.

Step 12: Combine R, G, B channels to get watermarked image 'WI'.

It helps to improve the copyright protection of the cover image and robustness of the watermark in the watermarked image.

b) *Watermark Extraction Algorithm*

Extraction of watermark image from watermarked image is explained as follows and it is shown in Fig 2.

Algorithm

Step 1: Get R, G, B channels of watermarked image 'WI'.

Step 2: Apply DWT to blue channel 'B' to get the multi-resolution sub-bands LL1, HL1, LH1, and HH1.

Step 3: Apply DWT again to HL1 sub-band of B channel and choose HL2 sub-band.

Step 4: Divide the HL2 sub-band into blocks of size 8×8.

Step 5: Apply DCT to the blocks obtained in step 4

Step 6: Obtain four DCT coefficients of watermark from the four selected coefficients of mid frequency band of each DCT of HL2 sub-band.

Step 7: To get the watermark apply IDCT on the set of DCT coefficients obtained from previous step.

III. Performance Evaluation Metrics

To measure the quality of the watermarked image peak signal to noise ratio (PSNR) is used. The quality of extracted watermark is measured using Normalized Correlation (NC) between the extracted and the original watermark.

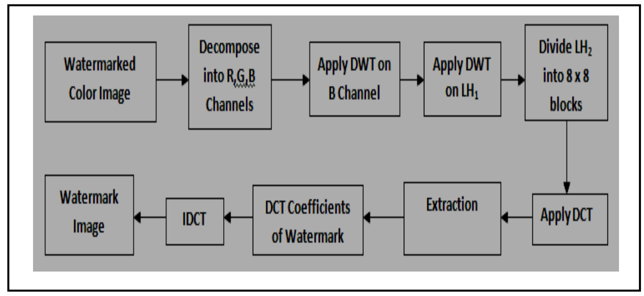

Figure 2 : Watermark extraction process

a) *Peak Signal to Noise Ratio*

It is a metric which is used regularly to find the quality of the watermarked image. It is calculated by considering the following formula

$$\text{PSNR}=\log\frac{(2^n-1)^2}{\text{MSE}}$$

Where n denotes the number of bits used for color representation and MSE refers to the Mean Square Error between original and water marked image and is calculated with the formula.

$$\text{MSE} = \frac{\sum_{R,G,B}\sum_{i=1}^{M}\sum_{j=1}^{N}(\text{I}[\text{i},\text{j}]-\text{I}'[\text{i},\text{j}])^2}{3\text{MN}}$$

Here, M and N are the height and width of image respectively. I[i, j] denotes the (i, j)th pixel value of the original image and I'[i, j] denotes the (i, j)th pixel value of watermarked image.

b) *Normalized Correlation (NC)*

It is one of the metrics used to find the quality of extracted watermark image with respect to the original watermark image. It is found by using the following formula.

$$\text{NC} = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N} w(i,j)w'(i,j)}{\sqrt{\sum_{i=1}^{M}\sum_{j=1}^{N} w(i,j)^\wedge 2}\sqrt{\sum_{i=1}^{M}\sum_{j=1}^{N} w'(i,j)^\wedge 2}}$$

Here, w(i, j) is the original watermark, w'(i, j) is the extracted watermark.

IV. Results and Analysis

As per this proposed method, a Lena color image of size 512×512 is considered as cover image as shown in Fig. 3 and Fig. 4 is a gray scale image of skeleton with size 32×32 is chosen as watermark.

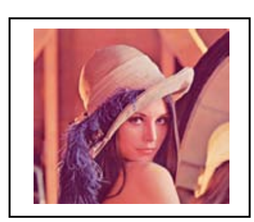

Figure 3 : Original Image

Figure 4 : Watermark image

Figure 5 : Watermarked image

After applying the proposed method the resultant watermarked image is shown as Fig.5.

Table 1 summarizes PSNR value of watermarked image and NC value of extracted watermark image when the watermarked image is not attacked and undergoes any attack like Gaussian noise, salt & pepper noise, Poisson noise, Gaussian blur, sharpening and image manipulation operations like cropping, JPEG compression are applied.

Table I : PSNR and NC values

Attack / Operation	PSNR	NC
No attack	85.76	1.000
Gaussian noise	65.46	0.996
Salt & Pepper noise	65.45	0.998
Poisson noise	85.76	1.000
Gaussian blur	79.18	0.998
Sharpening	68.73	0.995
Cropping	60.28	0.920
JPEG compression	63.45	0.910

Table 2 shows comparison results of the proposed method with the existing transformation methods such as DWT [5], DWT-DCT [9] and Bior [10] based on the NC value between original and extracted watermark when the watermarked image undergoes any attacks.

Table II : Comparison Results

Attack / Operation	DWT	DWT -DCT	Bior	DCT Coeff
Gaussian noise	0.7415	0.993	0.8575	0.996
Salt & Pepper noise	--	0.997	0.8518	0.998
Poisson noise	--	--	0.8567	1.000
Gaussian blur	0.8968	0.997	--	0.998
Sharpening	--	0.992	--	0.995
Cropping	0.9031	0.861	0.8484	0.920
JPEG compression	0.8775	0.756	0.7505	0.910

V. Conclusion

This robust watermarking method is proposed for increasing the security of data hiding as well as quality compared with the existing algorithms. Authenticity is incorporated by embedding the DCT coefficients of watermark image into the transformed image. Experimental results based on attacks confirm that the proposed algorithm performs better than the DWT, DWT-DCT and Bior based scheme and robustness is achieved by hiding DCT coefficients of watermark image in transformed image by the frequency transformations as DWT and DCT.

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